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Please find below and/or attached an Office communication concerning this application or proceeding.

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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 10/685,785
Filing Date: October 16, 2003
Appellant(s): THOMPSON ET AL.

Gerald L. Coon
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 09/09/2008 appealing from the Office action mailed 05/20/2008.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

6,465,669	OKAMOTO	10-2002
4,970,093	SEIVERS ET AL	11-1990
6,482,740	SOININEN ET AL	11-2002

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

1. Claims 1-13, 16-22, 24, 25, 28-32, 34, and 37-39 are rejected under 35 U.S.C. 103(a) as being unpatentable over Okamoto (‘669) in view of Sievers et al (‘093).

Okamoto teaches a process for producing at least one member of the group consisting of a film, a coating and a powder, comprising the step of decomposing at least one asymmetric metallocene precursor having a general formula CpMCp', where M is a metal selected from the group consisting of Ru, Os and Fe; Cp is a first substituted cyclopentadienyl or a cyclopentadienyl-like moiety that includes at least one substituent group D.sub.1; Cp' is a second substituted cyclopentadienyl or a cyclopentadienyl-like moiety that includes at least one substituent group D.sub.l'; wherein D.sub.1 is different from D.sub.l'; D.sub.1 is selected from the group consisting of: X; C.sub.alH.sub.blX.sub.cl;

C.sub.a2 H .sub. b2X.sub.c2(C.dbd.O)C.sub.a 1 H.sub.bl X.sub.cl;

C.sub.a2H .sub.b2X.sub.c2OC.sub.a 1 H.sub.b 1X.su b.cl;

C.sub.a2H.sub.b2X.sub.c2(C.dbd.O)OC.sub.alH.sub.blX.sub.cl; and

C.sub.a2H.sub.b2X.sub.c20(C.dbd.O)C.sub.alH.sub.blX.sub.cl;

where X is a halogen atom; al is an integer from 2 to 8; bl is an integer from 0 to 2(al)+1-cl; cl is an integer from 0 to 2(a1)+1-b1; bl+cl is at least 1; a2 is an integer from 0 to 8; b2 is an integer from 0 to 2(a2)+1-c2; c2 is an integer from 0 to 2(a2)+1-b2; and D.sub.l' is selected from the group consisting of: X C.sub.alH.sub.blX.sub.cl,

C.sub.a2H.sub.b2X.sub.c2- (C.dbd.O)C.sub.alH.sub.blX.sub.cl,

C.sub.a2H.sub.b2X.sub.c2OC.sub.alH.sub.blX.sub.cl,

C.sub.a2H.sub.b2X.sub.c2(C.dbd.O)OC.sub.alH.sub.blX.sub.cl, and

C.sub.a2H.sub.b2X.sub.c20(C.dbd.O)C.sub.alH.sub.blX.sub.cl where, X is Fl, Cl, Br or I; al is an integer from 1to 8; bl is an integer from 0 to 2(al)+1-cl; cl is an integer from 0 to 2(a1)+1-b1; bl+cl is equal to or greater than 1; a2 is an integer from 0 to 8; b2 is an integer from 0 to 2(a2)+1-c2; c2 is an integer from 0 to 2(a2)+1-b2; and b2+c2 is equal to or greater than 1, thereby producing the film, coating or powder at column 3, lines 1-20 and column 5. Given the general formula and description of the substituents R1 -R5 and Rl'-R5' at column 3, lines 1-31, one could readily envisage compounds falling within the claimed general formula CpRuCp' wherein Cp has a substituent D1 and Cp' has a substituent D'l and both are described by CalHb~Xcl and are different. Alternatively, such compounds are clearly encompassed by the formula of Okamoto and would be expected to have the increased thermal stability taught as described at column 3, lines 29-31 through the use of bulky substituents, as such it would have been obvious to select these species with a reasonable expectation of there being operable for depositing Ru-containing films and providing increased thermal stability of the precursor.

In regard to claim 2, Okamoto teaches a process for producing a film, comprising the step of decomposing at least one precursor in the presence of a substrate, wherein the decomposition is thermal, chemical, photochemical or plasma-activated, and said precursor has a general formula CpMCp', where M is a metal selected from the group consisting of Ru, Os and Fe; Cp is a first substituted cyclopentadienyl or indenyl moiety that includes at least one substituent group D.sub.1; Cp' is a second substituted cyclopentadienyl or indenyl moiety that includes at least one substituent group D.sub.l'; wherein D.sub.1 is different from D.sub.l'; D.sub.1 is selected from the group consisting of: X; C.sub.alH.sub.blX.sub.cl; C.sub.a2H.sub.b2X.sub.c2(C.dbd.O)C.sub.alH.sub.blX.sub.cl; C.sub.a2H.sub.b2X.sub.c2OC.sub.alH.sub\-.blX.sub.cl; C.sub.a2H.sub.b2X.sub.c2(C.dbd.O)OC.sub.alH.sub.blX.sub.cl; and C.sub.a2H.sub.b2X.sub.c20(C.dbd.O)C.sub.alH.sub.blX.sub.cl; where X is a halogen atom; al is an integer from 2 to 8; bl is an integer from 0 to 2(al)+1-cl; cl is an integer from 0 to2(a1)+1-b1; bl+cl is at least 1; a2 is an integer from 0 to 8; b2 is an integer from 0 to 2(a2)+1-c2; c2 is an integer from 0 to 2(a2)+1-b2; and Dl' is selected from the group consisting of: X C.sub.alH.sub.blX.sub.cl, C.sub.a2H.sub.b2X.sub.c2(C.dbd-°.O)C.sub.al H.sub.blX.sub.cl, C.sub.a2H.sub.b2X.sub.c2OC~sub.al H.sub.blX.su\- b.cl, C.sub.a2H.sub.b2X.sub.c2(C.dbd.O)OC.sub.alH.sub.blX.sub.cl, and C.sub.a2H.sub.b2X.sub.c20(C.dbd.O)C.sub.alH.sub.blX.sub.cl where, X is Fl, Cl, Br or

I; al is an integer from 1to 8; bl is an integer from 0 to 2(al)+1-cl; cl is an integer from 0 to 2(a1)+1-b1; bl+cl is equal to or greater than 1; a2 is an integer from 0 to 8; b2 is an integer from 0 to 2(a2)+1-c2; c2 is an integer from 0 to 2(a2)+1-b2; and b2+c2 is equal to or greater than 1, thereby forming a film on the substrate powder at column 3, lines 1-20, Cp and Cp' are the substituents of the cyclopentadiene ring column 3, lines 1-20. Given the general formula and description of the substituents R1 -R5 and RI' -R5' at column 3, lines 1-31, one could readily envisage compounds falling within the claimed general formula CpRuCp' wherein Cp has a substituent D1 and Cp' has a substituent D'I and both are described by CalHblXc~ and are different. Alternatively, such compounds are clearly encompassed by the formula of Okamoto and would be expected to have the increased thermal stability taught as described at column 3, lines 29-31 through the use of bulky substituents, as such it would, have been obvious to select these species with a reasonable expectation of there being operable for depositing Ru-containing films and providing increased thermal stability of the precursor. Okamoto teaches the film includes ruthenium at column 4, lines 55-67 or the film includes ruthenium oxide at column 1, lines 8.

Okamoto does not disclose conducting the decomposition in the presence of a solvent fluid.

Sievers discloses that providing CVD precursors to a CVD reactor by dissolving them in supercritical solvents allows precise control of stoichiometry and high deposition rates (Abstract; column 2, lines 50-60).

It would have been obvious to one of ordinary skill in the art at the time of invention by applicant to deliver the precursors of Okamoto to the CVD chamber using supercritical solvents as suggested by Sievers in order to achieve precise control over stoichiometry and improved deposition rates.

In regard to claim 3, Okamoto teaches the process of claim 2, wherein either or both of Cp and Cp' moiety includes at least one additional substituent, D.sub.x, selected from the group consisting of: X C.sub.alH.sub.blX.sub.cl, C.sub.a2H.sub.b2X.sub.c2-(C.dbd.O)C.sub.alH.sub.blX.sub.cl, C.sub.a2H.sub.b2X.sub.c2OC.sub.alH.sub.-blX.sub.cl, C.sub.a2H.sub.b2X.sub.c2(C.dbd.O)OC.sub.alH.sub.blX.sub.cl, and C.sub.a2H.sub.b2X.sub.c20(C.dbd.O)C.sub.alH.sub.blX.sub.cl, where, X is Fl, Cl, Br or I; al is an integer from 0 to 8; bl is an integer from 0 to 2(al)+1-cl; cl is an integer from 0 to 2(a1)+1-b1; bl+cl is equal to or greater than 1; a2 is an integer from 0 to 8; b2 is an integer from 0 to 2(a2)+1-c2; c2 is an integer from 0 to 2(a2)+1-b2; and b2+c2 is equal to or greater than 1 at column 3, lines 1-20.

In regard to claim 4, Okamoto teaches the process of claim 2, wherein said precursor is vaporized and the vapor is directed into a deposition reactor housing the substrate at column 5, lines 6-10.

In regard to claim 5, Okamoto teaches the process of claim 4, wherein the deposition reactor is at a pressure in the range of from about 0.01 Torr and about 760 Torr at column 5, lines 13-18 (0.5 Torr).

In regard to claim 6, Okamoto teaches the process of claim 5, wherein the deposition reactor is at a pressure in the range of from about 0.1 Torr and about 760 Torr at column 5, lines 13-18 (0.5 Torr).

In regard to claim 7, Okamoto teaches the process of claim 6, wherein the deposition reactor is at a pressure in the range of from about 1 Torr and about 50 Torr at column 8, line 10.

In regard to claim 8, Okamoto teaches the process of claim 2, wherein the substrate is at a temperature in the range of from about 75.degree. C. to about 700.degree. C at column 5, lines 1-18.

In regard to claim 9, Okamoto teaches the process of claim 8, wherein the substrate is at a temperature in the range of from about 250.degree. C. to about 450.degree. C at column 5, lines 13-18. (200 °C is deemed to be encompassed by about 250 °C).

In regard to claim 10, Okamoto teaches the process of claim 2, wherein the substrate is comprised of a material selected from the group consisting of a metal; a metal silicide; a semiconductor; an insulator and a barrier material at column 8, lines 1-5 (silicon dioxide).

In regard to claim 11, Okamoto teaches the process of claim 2, wherein the substrate is a wafer at column 8, lines 66-67 to column 9, lines 1-2.

In regard to claim 12, Okamoto teaches the process of claim 2, wherein the process includes decomposing an organometallic precursor at column 4, lines 24-34.

In regard to claim 13, Okamoto teaches the process of claim 2, wherein vapor of said precursor is combined with a carrier gas at column 5, lines 13-18.

In regard to claim 16, Okamoto teaches combination of the Ru precursor with hydrogen reactant gas to form a process gas at column 5, lines 5-20.

In regard to claim 17, this gas is supplied to a MOCVD reactor (Figure #1).

In regard to claim 18, Okamoto depicts exhaust of gas in Figure # 1 to maintain a pressure of 0.5 Torr as disclosed at column 5, lines 5-20.

In regard to claim 19, Okamoto teaches the process of claim 2, wherein said precursor is 1-methyl,l'-ethyl ruthenocene at column 3, general formula (1)for D and D' and at column 6, lines 8-11.

In regard to claim 20, Okamoto teaches the process of claim 2 wherein D.sub.1 is methyl and D.sub.l' is selected from the group consisting of ethyl, propyl, isopropyl, n-butyl, sec-butyl and tert-butyl at column 3, general formula (1) for D and D' and at column 3, lines 32-37.

In regard to claim 21, Okamoto teaches the process of claim 2, wherein D.sub.1 is ethyl and D.sub.l' is selected from the group consisting of propyl, isopropyl, n-butyl, sec-butyl and tert-butyl at column 3, general formula (1) for D and D' and at column 3, lines 32- 37.

In regard to claim 22, Okamoto teaches the process of claim 2, wherein D.sub.1 is propyl and D.sub.l' is selected from the group consisting of isopropyl, n-butyl, sec-butyl and tert-butyl at column 3, general formula (1).for D and D' and at column 3, lines 32- 37.

In regard to claim 24, Okamoto teaches the process of claim 2, wherein D.sub. 1 is n- butyl and D.sub.l' is selected from the group consisting of sec-butyl and tert-butyl at column 3, general formula (1) for D and D' and at column 3, lines 32-37.

In regard to claim 25, Okamoto teaches the process of claim 2, wherein D.sub.1 is sec- butyl and D.sub.l' is tert-butyl at column 3, general formula (1) for D and D' and at column 3, lines 32-37.

In regard to claim 28, Okamoto teaches the process of claim 2, wherein the film has a thickness that is less than about 500 nanometer at column 1, line 8.

In regard to claim 29, Okamoto teaches the process of claim 2, wherein the film has a thickness that is less than about 200 nanometer at column 7, Tables 1 & 2.

In regard to claim 30, Okamoto teaches the process of claim 2, wherein the film has a thickness that is less than 50 nanometer at column 7, Tables 1 & 2.

In regard to claim 31, Okamoto teaches the process of claim 2, wherein the film has a thickness that is less than about 30 nanometer at column 7, Tables 1 & 2.

In regard to claim 32, Okamoto teaches the process of claim 2, wherein said precursor is represented by the following molecular formula at column 3, generalformula (1) for D and D' and at column 3, lines 1-20.

In regard to claim 37, Okamoto teaches the process of claim 1, wherein the film, coating or powder is produced by a gas phase deposition at column 5, lines 5-20.

In regard to claim 38, Okamoto teaches the process of claim 1,wherein the film, coating or powder is produced in-situ at column 5, lines 5-20.

In regard to claim 39, Okamoto teaches the process of claim 2, wherein D.sub.1 is isopropyl and D.sub.l' is selected from the group consisting of n-butyl, sec-butyl and tert-butyl at column 3, general formula (1) for D and D' and at column 3, lines 32- 37.

Thus, claims 1-13, 16-22, 24, 25, 28-32, 34, and 37-39 would have been obvious within the meaning of 35 USC 103 over the combined teachings of Okamoto and Sievers.

2. Claims 14, 15, 35, and 36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Okamoto in view of Sievers as applied above and further in view of Soininen et al (‘740).

Okamoto discloses deposition of RuO but does not explicitly disclose combining the precursor with an oxidizing component such as oxygen or ozone or deposition of the Ru- containing films in layers or by ALD.

Soininen discloses deposition of RuO films by ALD by combining pulses of a Ru precursor having sufficient volatility and high thermal stability with pulses of oxidizing gases such as ozone or oxygen at column 6, lines 43 to column 7, lines, 5; column 9, lines 40-50; and column 11, lines 25-30. Soininen further teaches that use of ALD to deposit these films provides excellent step coverage along with dense and pinhole free structures.

It would have been obvious to one of ordinary skill in the art at the time of invention by applicant to provide RuO layers by combining the precursors of Okamoto with oxidizing gases such as oxygen or ozone and deposit the layers using ALD as suggested by Soininen in order to form RuO films with excellent step coverage that are dense and pinhole free.

Thus, claims 14, 15, 35, and 36 would have been obvious within the meaning of 35 USC 103 over the combined teachings of Okamoto, Sievers, and Soininen.

(10) Response to Argument

Rejection of Claims 1-13, 16-22, 24, 25, 28-32, 34, and 37-39 under 35 U.S.C. 103(a)

Applicant argues that Okamoto does not disclose asymmetric metallocene precursors used in deposition processes as claimed because Okamoto only discloses symmetric metallocene precursors and an asymmetric precursor in which only one 5-membered ring is substituted in the embodiments. The examiner disagrees. The formula disclosed at Col. 3, lines 1-20 in Okamoto suggests that both of the 5-membered rings may include substituents, such as claimed in applicant's invention, and one of ordinary skill in the art would have readily envisaged using any combination of substituents on the 5-membered rings within the scope of the formula. Most of the embodiments of Okamoto exemplify symmetric metallocenes wherein both 5-membered rings are substituted with the same alkyl groups (embodiments 1-4), however, Okamoto does disclose using an asymmetric metallocene in one of the embodiments (embodiment 5). Thus, one of ordinary skill in the art would have readily envisaged using any combination of substituents within the scope of the formula, wherein these substituents need not be the same, since it would have been obvious that symmetric and asymmetric metallocenes were functional within the scope of Okamoto.

Applicant argues that Okamoto does not remotely disclose, suggest, or exemplify the unexpected advantages resulting from using asymmetric metallocene precursors. The evidence relied upon (Ex. 10 of Appellants' specification, wherein 1-methyl,1'ethylruthenocene is compared to 1,1'-diethylruthenocene) is not commensurate in scope with the claims which the evidence is offered to support since the claims include metallocene precursors having substituents other than methyl and ethyl.

Rejection of Claims 19-20 under 35 U.S.C. 103(a)

Applicant argues that claims 19 and 20 are patentable over the cited references in view of the comparative data from Ex. 10 of Appellants' specification showing the unexpectedly improved properties of films deposited using 1-methyl,1'-ethylruthenocene compared to films produced using 1,1'-diethylruthenocene. The examiner disagrees. The unexpectedly improved properties (lower sheet resistance, film thickness, resistivity) shown by Ex. 10 is attributed to 1-methyl,1'-ethylruthenocene having a higher vapor pressure than 1,1'-diethylruthenocene (See Arguments, p. 6, ¶ 2-4). Okamoto teaches that the ruthenium precursors of structural formula (1) are more bulky and have higher vapor pressures than conventional ruthenium precursors. Okamoto also teaches that precursors having higher vapor pressures are desirable because a constant vaporization rate can be attained (Col. 1, lines 55-63, Col. 3, lines 1-47). Thus, it would have been obvious to one of ordinary skill in the art to incorporate any combination of substituents disclosed by Okamoto, through routine experimentation in order to provide precursors with high vapor pressures to attain a constant vaporization rate.

Applicant also notes that structural formula 1 of Okamoto (Col. 3, lines 1-20) excludes methyl. The examiner agrees, however, Okamoto does disclose using methyl substituted ruthenocenes in the comparative examples (Col. 6, lines 29-58) and that the alkyl substituted ruthenocenes of general formula 1 have a higher molecular weight than the comparative compounds and thereby have a higher vapor pressure. Thus, it would have been obvious to one of ordinary skill to use a known substituent, such as methyl, with a bulkier substituent, such as ethyl, propyl, etc., in order to increase the molecular weight since Okamoto discloses that any of the substituents may include a bulky alkyl group and the incorporation of a higher molecular weight substituent with a methyl substituent would have reasonably been expected to provide a precursor having a higher molecular weight than a precursor having two methyl groups.

Regarding Claim 20, the evidence relied upon (Ex. 10 of Appellants' specification, wherein 1-methyl,1'ethylruthenocene is compared to 1,1'-diethylruthenocene) is not commensurate in scope with the claims which the evidence is offered to support since the claims include metallocene precursors having substituents other than methyl and ethyl.

Rejection of Claims 14, 15, 35, and 36 under 35 U.S.C. 103(a)

Applicant argues that Soininen does not cure the deficiencies of Okamoto and Seivers. These deficiencies have been addressed above.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

/Elizabeth Burkhart/

Examiner, Art Unit 1792

Conferees:

/Timothy H Meeks/

Supervisory Patent Examiner, Art Unit 1792

/Jennifer Michener/

QAS, TC1700